

CLAIMS

We claim:

- 1 1. A method for generating multiple unique real non-linear
2 constellations each representing different time slots
3 corresponding to a set of network CODEC linear output levels for
4 each digital PCM code from the server modem, said method
5 comprising the steps of:
6 receiving, in an analog modem, the linear output of a
7 network CODEC converted from PCM coded data transmitted by a
8 network server modem, the linear data comprising a number of data
9 points in a predetermined number of slots,
10 averaging, in the analog modem, the linear data, for each
11 digital PCM code, for each of the time slots, to generate a
12 statistical estimate of the linear data corresponding to the real
13 non-linear constellation points to produce estimated real non-
14 linear constellation points,
15 converting, using a first converting algorithm, to map the
16 estimated real non-linear constellation points to the network
17 CODEC linear output levels,
18 matching, in the analog modem, for selecting closest ideal
19 CODEC output levels for a selected type of network CODEC, and

20 converting, using an inverse the first converting algorithm,
21 to re-map the closest ideal CODEC output levels back to real non-
22 linear constellation points.

1 2. The method of claim 1, wherein the preselected frame
2 size comprises one of 6 slots, 12 slots, or 24 slots.

1 3. The method of claim 1, wherein the converting algorithm
2 comprises the steps of:
3 detecting digital PAD attenuation, and
4 multiplying the linear values by an estimated digital PAD
5 attenuation for mapping to CODEC output values.

1 4. The method of claim 1, wherein the matching algorithm
2 comprises the steps of:
3 detecting the type of the network CODEC, and
4 slicing the converted linear values to ideal CODEC output
5 values.

1 5. The method of claim 3, further comprising the steps of:
2 detecting inter-modulation distortion, and
3 applying an additional level dependent multiplication to the
4 linear values for mapping to CODEC output if inter-modulation
5 distortion is detected.

1 6. The method of claim 1, wherein said averaging step
2 further comprises the steps of:
3 grouping similar Robbed Bit Signalling slots, and
4 averaging constellation points of the similar Robbed Bit
5 Signalling slots, thus reducing the number of real non-linear
6 constellations.

1 7. The method of claim 6, wherein said averaging step
2 comprises the step of:
3 averaging only for Non-Robbed Bit Signaling slots.

1 8. The method of claim 4, wherein linear data output of the
2 network CODEC is according to one of G711 μ -law CODEC output
3 levels, G711 A-law CODEC output levels, or output levels

4 corresponding to D4 channel bank CODECs specified in AT&T
5 Technical Reference, PUB 43801, November 1982.

1 9. The method of claim 1, further comprising the step of:
2 limiting the largest constellation point to a level
3 supported by hardware before saturation.

1 10. The method of claim 1, further comprising the steps of:
2 calculating and inserting ideal values which correspond to
3 missing PCM codes into the constellations, when low level PCM
4 codes are not signaled due to statistical requirements and when
5 the line noise is small enough to support such low PCM codes.

1 11. The method of claim 1, further comprising the steps of:
2 eliminating constellation points which are non-monotonic due
3 to presence of heavy impairments or a non-standard network CODEC.

1 12. The method of claim 3, wherein a failure in PAD
2 detection in said detecting step is treated as a 0 dB PAD and raw
3 averaged data is used as the real non-linear constellation points.

1 13. The method of claim 4, wherein if CODEC detection
2 fails, the raw averaged data is used as the constellation points.

1 14. An apparatus to generate multiple unique real non-
2 linear constellations each representing different time slots
3 corresponding to a set of network CODEC linear output levels for
4 each digital PCM code from the server modem, said apparatus
5 comprising:

6 an analog modem for receiving linear output of a network
7 CODEC converted from PCM coded data transmitted by a digital
8 server, the linear data comprising a number of data points in a
9 predetermined number of slots;

10 averaging means, coupled to the analog modem, for averaging
11 each of the PCM codes, for each of the time slot, to generate a
12 statistical estimate of the linear data corresponding to the real
13 non-linear constellation points to produce estimated real non-
14 linear constellation points;

15 first converting means, coupled to the averaging means, for
16 mapping, using a converting algorithm, the estimated real non-
17 linear constellation points to the network CODEC linear output
18 levels;

19 matching means, coupled to the first converting means, for
 20 selecting closest ideal CODEC outputs for network CODEC type;
 21 second converting means, coupled to matching means, for re-
 22 mapping, using an inverse of the converting algorithm, the
 23 closest ideal CODEC output levels back to real non-linear
 24 constellation points.

1 15. The apparatus of claim 14, wherein the preselected
 2 frame size is one of 6 slots, 12 slots, or 24 slots.

1 16. The apparatus of claim 14, wherein said first
 2 converting means comprises:
 3 means for detecting digital PAD attenuation; and
 4 means for multiplying the linear values by an estimated
 5 digital PAD attenuation for mapping to CODEC output values.

1 17. The apparatus of claim 14, wherein said matching means
 2 comprises:
 3 means for detecting the type of the Network CODEC; and
 4 means for slicing the converted linear values to ideal CODEC
 5 output values.

18. The apparatus of claim 16, further comprising:
 means for detecting inter-modulation distortion; and
 means for applying an additional level dependent
 multiplication to the linear values for mapping to CODEC output
 if inter-modulation distortion is detected.

19. The apparatus of claim 14, wherein said means for
 averaging further comprises:
 means for grouping similar Robbed Bit Signalling slots; and
 means for averaging constellation points of similar Robbed
 Bit Signalling slots, thus reducing the number of real non-linear
 constellations.

20. The apparatus of claim 19, wherein said means for
 averaging further comprises:
 means for averaging only for Non-Robbed Bit Signalling
 slots.

21. The apparatus of claim 17, wherein linear data output
 of the network CODEC is according to one of G711 μ -law CODEC
 output levels, G711 A-law CODEC output levels, or output levels

4 corresponding to D4 channel bank CODECs specified in AT&T
5 Technical Reference, PUB 43801, November 1982.

1 22. The apparatus of claim 14, further comprising:
2 means for limiting the largest constellation point to a
3 level supported by hardware before saturation.

1 23. The apparatus of claim 14, further comprising:
2 means for calculating and inserting ideal values
3 corresponding to missing PCM codes in to the constellations, when
4 low level PCM codes are not signaled due to statistical
5 requirements and when line noise is small enough to support those
6 low PCM codes.

1 24. The apparatus of claim 14, further comprising:
2 means for eliminating constellation points that are non-
3 monotonic due to presence of heavy impairments or a non-standard
4 network CODEC.

1 25. The apparatus in claim 16, wherein a failure in PAD
2 detection is treated as 0 dB PAD and the raw average of the
3 linear data is used as the real non-linear constellation points.

1 26. The apparatus of claim 17, wherein a failure in CODEC
2 detection results in the raw averaged data to be used as the
3 constellation points.